deep mesal trench. Claspers elongate, curved ventrad, apical incision creates a slender dorsal and a wide ventral process, apices bear long slender setae; from dorsal aspect, basal portion of clasper appears greatly inflated. Aedeagus discernible through ninth segment, elliptical, simple, apex truncate.

Holotype male.—COTTONWOOD CREEK, MONO COUNTY, CALIFORNIA, 9,300 feet, 10 July 1961.

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Three New Species of the Genus *Anomiopsyllus*

(Siphonaptera : Hystrichopsyllidae)

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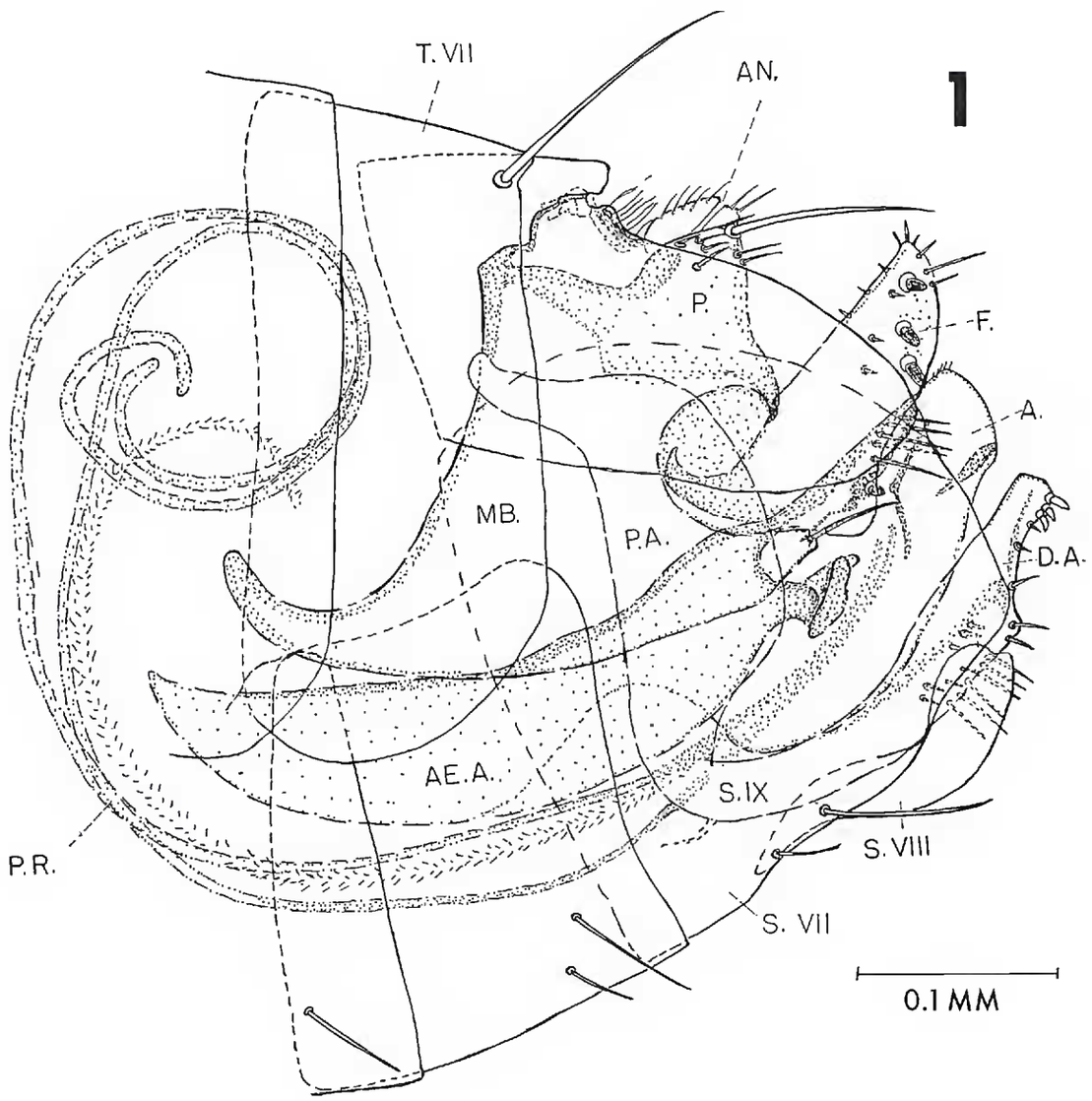
The genus *Anomiopsyllus* is composed of small, eyeless, nest-dwelling fleas parasitic on wood rats in western North America. As reviewed recently by Hopkins and Rothschild (1962), the genus contains seven species whose known distributions lie entirely within the nearctic region from near Banff, Alberta, Canada to the approximate latitude of Mexico City, Mexico. In the course of more extensive taxonomic and biological studies on the group (Barnes, 1963), three new species have come to light, one of which extends the known range of the genus to the edge of the neotropical region in southwestern Mexico. The present paper presents descriptions of these new species with brief notes on distribution and host occurrence.

Anomiopsyllus walkeri Barnes, new species

(Fig. 1)

This species is most closely related to *A. nudatus*, but is readily distinguishable in males by the presence of three rather than two spiniform setae in the subapical vertical row along the posterior margin of the clasper, and by the configuration of the dorsal margin of the aedeagus



EXPLANATION OF FIGURES

Fig. 1. *Anomiopsyllus walkeri* Barnes, male genital segments. A., aedeagus; Ae.A., aedeagal apodeme; An., anus; D.A., distal arm of sternum IX; F., finger or movable process of clasper; Mb., manubrium; P., fixed process of clasper; P.A., proximal arm of sternum IX; S., sternum; T., tergum.

as described below. Females are apparently indistinguishable from *A. nudatus*.

MALE.—Head and thorax as in *A. nudatus*. Abdominal tergum I with row of three, tergum II with four, and terga III to VII with three submarginal setae plus minute intercalary setae. Terga VIII and IX, fixed process of clasper, and manubrium as in *A. nudatus*. Movable process of clasper with four heavy, blunt, posteriorly directed submarginal spiniform setae, three in a vertical, subapical row; one proximal near base. Sternum IX proximal arm as in *A. nudatus*; distal arm narrower, the apex truncate, its setation as in *A. nudatus*. Aedeagus differing markedly from *A. nudatus*, its dorsal margin heavily sclerotized and possessing a well-defined median dorsal "hump" above and slightly anterior to the aedeagal struts; neck of aedeagus downcurved from longitudinal axis; apodeme strongly upcurved, scimitar shaped, apical appendage present; penis rods curved as in *A. nudatus*.

Holotype male and allotype female from 7.0 MILES SOUTH, 5.6 MILES EAST OF TEHACHAPI, KERN COUNTY, CALIFORNIA, 19 February 1959, by A. M. Barnes from the nests of *Neotoma fuscipes* Baird. Seven male and 19 female paratypes were collected from the type locality on 19 February 1959, two females on 2 April 1959, and 22 males, 30 females on 22 January 1960. Also designated as paratypes are: 1 male, 8 females from 1.7 miles northwest of Keene, Kern County, 18 February 1959; 2 males, 3 females, collected 2 to 4 miles southwest of Glenville, Kern County, on 17 February 1959; 2 males, 1 female from 1.8 miles north, 0.7 miles west of Weldon, Kern County, on 16 March 1960; 5 males, 13 females from 3.2 miles east of Lake Isabella, Kern County, on 18 March 1960; 2 males, 2 females in Tulare County, 5.2 miles south, 6.3 miles west of Little Lake, Inyo County. All localities are in California and all collections from nests of *Neotoma fuscipes*.

TYPE HOST.—*Neotoma fuscipes* Baird.

The holotype male and allotype female will be deposited in the U. S. National Museum. Paratypes will be placed in the following collections: Museum of the California Insect Survey, University of California, Berkeley; Bureau of Vector Control, California Department of Public Health, Berkeley; British Museum (Natural History), Tring, Hertfordshire, England; San Francisco Field Station, Communicable Disease Center, U. S. Public Health Service; private collection of Dr. Robert Traub, Bethesda, Maryland.

DISCUSSION.—*A. walkeri* replaces *A. nudatus* in portions of the Tehachapi and southern Sierra Nevada mountains of California. This sort of replacement is typical of *Anomiopsyllus* distribution; collection of two *Anomiopsyllus* species from the same nest, or even the same wood rat colony are exceedingly rare. The distribution of these two species, plus the morphological similarities between them, at first suggest that *A. walkeri* might better be treated as a subspecies of *A. nudatus*. With this in mind, the area of contact between the two species was examined, with special attention given the possibility of morphological intergradation and to the habitats in which the two species were found.

Substantial numbers of wood rat (*N. fuscipes*) nests were collected from the type locality and adjacent areas during winter and spring of 1959 and 1960. *Anomiopsyllus* adults typically reach their peak abundance during these seasons. Fleas were removed from nests by means of a modified Berlese funnel and examined. Habitat notes were taken along with notes on weather conditions at the time of collection.

The type locality of *A. walkeri* is on the east slope of Double Mountain, the easternmost peak of the Tehachapi chain, at 4,800 to 5,200 feet elevation. Dominant vegetation consists of juniper–Joshua tree woodland (*Juniperus occidentalis* and *Yucca brevifolia*), sagebrush (*Artemisia* sp.), and several species of *Eriogonum*. This area, though desert in character, usually has some persistent patches of snow during midwinter. Average annual rainfall at nearby stations at similar elevations is approximately 11 inches (Climatic Summary of the U. S., 1952). To the south are alluvial fans grading into Antelope Valley, a relatively flat plain sloping gradually from about 3,500 to 2,500 feet to the south and east. The valley is largely under cultivation or development, but on the alluvial fans and in remaining natural areas on the valley floor, juniper–Joshua tree woodland still exists as habitat for *N. fuscipes*. At lower elevations, creosote bush (*Larrea tridentata*), a shrub characteristic of moderate elevations and gentle slopes in the Mojave Desert, is a codominant. Rare winter snows do not persist even for a day in Antelope Valley, nor on the slopes of Double Mountain below 4,000 feet. Average annual precipitation is 5.18 inches at Lancaster and 6.36 inches at Mojave, two nearby stations below 3,500 feet elevation.

Nest collections were made at and near the type locality, on slopes at lower elevations, and in Antelope Valley on 19 February 1959, 1–2 April 1959, and on 22 January 1960. Of 51 nests collected, 34 contained fleas and 24 contained *Anomiopsyllus* spp., either *A. walkeri* or *A. nudatus*. *A. walkeri* alone was removed from 11 of 22 nests collected at 4,600 feet or above in juniper–Joshua tree woodland; *A. nudatus* alone was removed from 13 of 29 nests collected in juniper–Joshua tree–creosote bush at 4,200 feet or below. A total of 31 male *A. walkeri* was collected from nests taken at the higher elevations; 52 male *A. nudatus* were collected from nests at the lower. Females were not considered, since they could not be identified. No evidence of morphological intergradation was found.

From this evidence, it would appear that *A. walkeri* is better adapted to areas of some persistent winter snow and higher rainfall, while *A. nudatus* is better adapted to lower elevations characterized by no winter snow and less rainfall, marked by the occurrence of creosote bush. While in neither case is the rainfall great, the rainfall in *A. walkeri* habitat is roughly twice that of the valley below.

The occurrence of the two flea species in nests seems to be mutually exclusive, suggesting the possibility of competition between them. Further evidence of mutually exclusive competition between these species is gained from a view of collection records apart from their zone of

contact. During the present study, *A. nudatus* was collected elsewhere in California outside the range of *A. walkeri* at elevations up to 7,500 feet, far above the winter snow line, and in areas with average annual precipitations up to 35 inches or more (*e.g.*, Big Bear, California, with a 37.1-inch annual average). Collections of *A. nudatus* from the Sawtooth and Liebre Mountains near Sandburg, Los Angeles County, just south of Antelope Valley, and also from near Desert Springs, San Bernardino County, California, were made in the sort of habitat characteristically preempted by *A. walkeri* in the zone of contact between the species. *A. walkeri* is apparently absent from these areas, and was not found anywhere south, west, or east of the Tehachapi Mountains.

In view of its morphological differences, its lack of intergradation at a point of close contact, and despite its distributional pattern, *A. walkeri* must be considered a full species related to *A. nudatus*. These considerations further suggest that *A. walkeri* has evolved in isolation from *A. nudatus* and subsequently has been brought into contact with the parent species. The species is respectfully named for John R. Walker, California State Department of Public Health.

Anomiopsyllus princei Barnes, new species

(Fig. 2)

Most similar to *A. nudatus* and to *A. walkeri*, differing from the former by possessing three spiniform setae along the distal margin of the movable process of the male clasper; from the latter by presence of a row of 6–7 thick, heavy, long setae along the posterior margin of sternum IX and by the linear margin of the aedeagal dorsum.

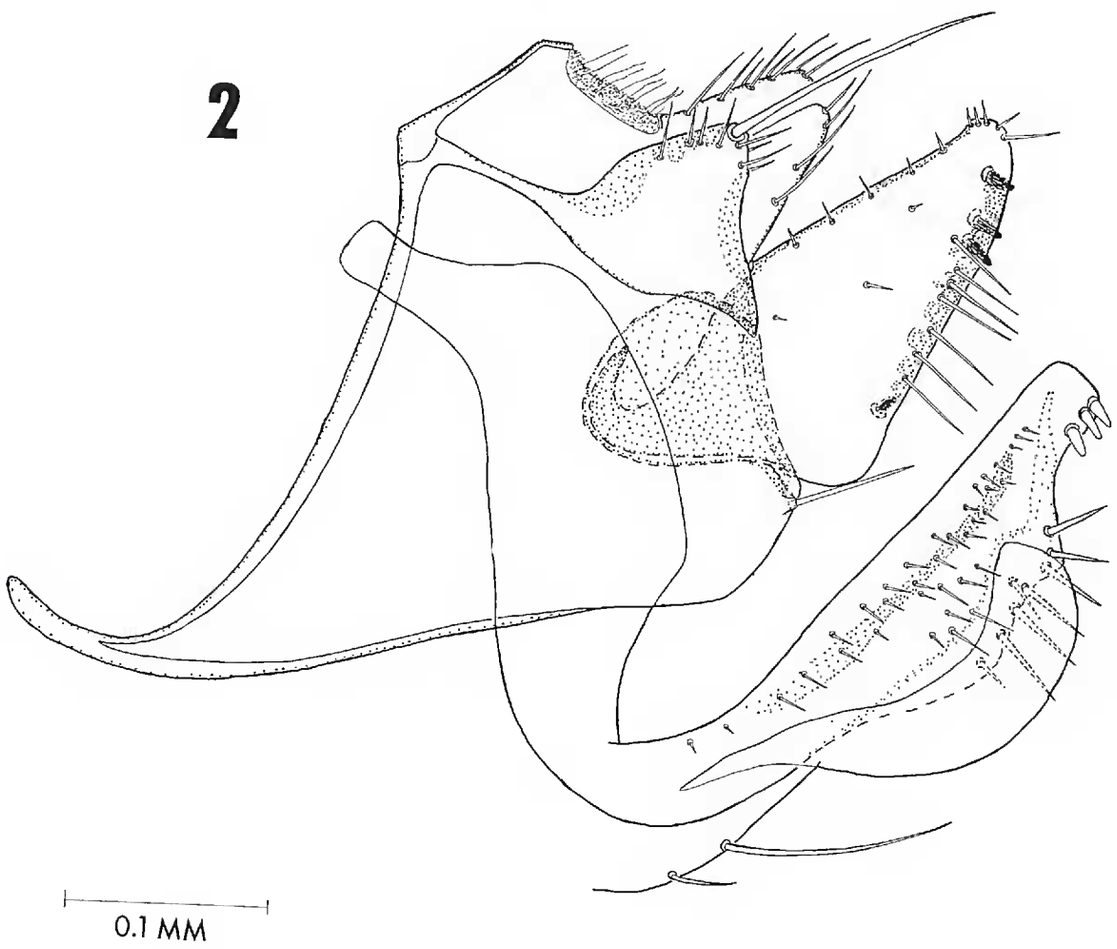
MALE.—Head, thorax, and unmodified abdominal segments as in *A. nudatus*. Male clasper movable process with four heavy, blunt spiniform setae, three distally in a row along posterior margin, one at proximal angle of posterior margin. Sternum IX similar to *A. nudatus* but with row of 6–7 thick, heavy setae along posterior margin. Aedeagal dorsal margin linear, with no lobes or projections.

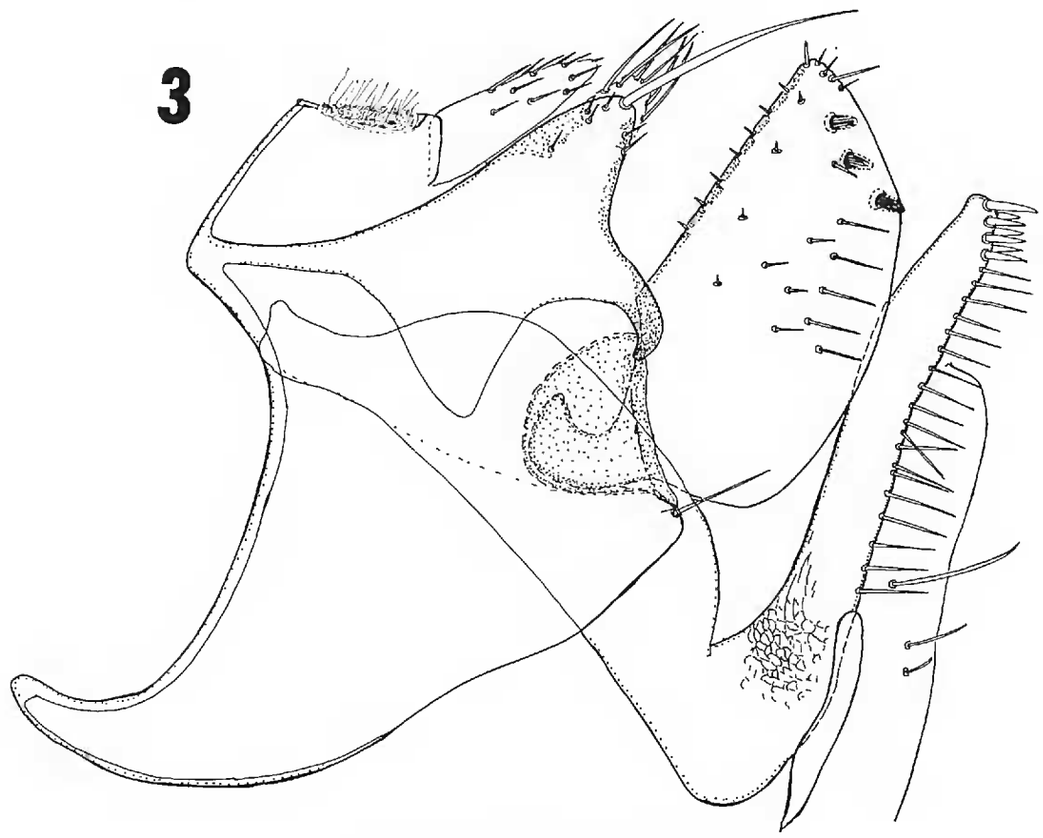
FEMALE.—Apparently indistinguishable from *A. nudatus*.

Holotype male and allotype female from 15 MILES NORTHEAST OF LUNA, ELEVATION 7,200 FEET, CATRON COUNTY, NEW MEXICO, 18 April 1940, U. S. Public Health Service collection no. D-2666. One male and two female paratypes were collected at other localities near Luna, Catron County, New Mexico, all from *Sciurus aberti aberti* Woodhouse, Abert's squirrel.

TYPE HOST.—*Sciurus aberti* Woodhouse.

The holotype male and allotype female will be deposited in the U. S. National Museum, Washington, D. C.; paratypes at the U. S. Public





EXPLANATION OF FIGURES

Fig. 2. *Anomiopsyllus princei* Barnes, male clasper and sternum IX. Fig. 3. *Anomiopsyllus oaxacae* Barnes, male clasper and sternum IX.

Health Field Station, San Francisco, California, and at the Bureau of Vector Control, State of California, Department of Public Health, Berkeley, California.

DISCUSSION.—*A. princei* appears to bear the same level of relationship to *A. nudatus* as does *A. walkeri.* In the case of *A. princei*, the aedeagus appears not to have been affected in the process of speciation.

The types were collected from specimens of *Sciurus aberti* within 15 miles of Luna, New Mexico, at elevations above 7,000 feet. *A. nudatus* has been collected extensively in the same area at elevations ranging from 4,600 to 8,000 feet. Most of the latter were taken from *Neotoma* spp.; none from *Sciurus aberti.* Many wood rats and their fleas were collected from Catron County and other localities in New Mexico by personnel of the U. S. Public Health Service plague survey crews during 1938 through 1940. Though most of the fleas were triturated and inoculated for plague, it is doubtful that additional specimens of so unusual a species would have escaped the scrutiny of Mr. Frank Prince, who identified most of the material and first noted this species as new. Despite the limited number of specimens available, it is reasonable to believe, at least until further study may prove differently, that *Sciurus aberti* rather than *Neotoma* spp. is the true host of *Anomiopsyllus princei.*

Anomiopsyllus oaxacae Barnes, new species

(Fig. 3)

Most closely related to *A. falsicalifornicus* but very different from that species and all other known *Anomiopsyllus* by possession of more and generally longer setae and reduction of sternum VIII of the male which forms a very small ventral sheath at the base of the distal arm of sternum IX.

MALE.—Head with frontal row of five minute, evenly spaced setae; ocular row of four setae, upper two moderately long, third one-half length of upper two, the lower 1.4 times length of upper two. Thorax similar to congeners, its setae longer than in other known species. Coxa I with row of three anterolateral setae in addition to the anterior submarginal row. Tarsal segment two of tarsus III with longest apical seta not reaching base of claws. Abdominal tergum I with three apical spinelets; tergum II with one. Tergum I with row of four submarginal setae; terga II to VI with five; tergum VII with three. Genital segments similar in structure to congeners except sternum VIII much reduced, forming a narrow sheath about the ventral angle of sternum IX distal arm. Clasper lobe and fixed process of tergum VIII similar to *A. falsicalifornicus*, the fixed process acuminately bell-shaped, its anterior margin convex, the posterior somewhat concave, the long terminal seta completely apical above four small basal submarginal setae. Manubrium roughly triangular, the anteroventral tip strongly curved, posterior margin

somewhat sinuous. Movable process of clasper broad, anterior margin linear, apex roundly angulate, the angle between anterior and posterodorsal margin approximately 45°, the latter margin dropping obliquely one-third length of process to its angle with posterior margin; posterior margin of movable process slightly convex, equipped with three heavy, blunt submarginal spiniform setae on inner surface in oblique row along posterodorsal margin; small setae of anterior margin spikelike, prominent; lateral setae in three indistinct, vertical rows of two anterior, three median, and five posterior setae, plus minute occasional setae; articulation of movable process heavily sclerotized, its acetabulum oblong, with one acetabular seta. Sternum IX proximal arm similar to *A. falsicalifornicus*, the dorsal margin convex, ventral margin relatively linear. Sternum IX distal arm long, narrow, the anterior margin slightly convex, the entire structure slightly curving posteriorly; apex armed with two posteriorly directed rows of heavy spikelike setae, the rows overlapping in lateral view, the outer row of six setae, the inner of three, the latter heavier, blunter; posterior margin with row of 20 evenly spaced, long, thin setae extending from near base of lowest of heavy apical setae three-fourths the distance to base of distal arm. Aedeagus apodeme broadly scimitar shaped, upcurved toward anterior tip, with small apical appendage; "neck" between apodeme and aedeagus proper well defined; aedeagal hood about equal to length of apodeme anterior to the hood; dorsal aspects of hood apparently collapsed in preparation, therefore not describable. Penis rods coiled. Length, 1.7 mm.

Holotype male, 2 MILES SOUTHEAST OF MATATLAN, OAXACA, MEXICO, 24 July 1953, collected by R. H. Baker. The holotype is the only specimen known.

TYPE HOST.—*Baiomys musculus* (Merriam).

The holotype male will be deposited in the National Museum, Washington, D. C.

This species is described from the single male specimen loaned the author by Dr. R. W. Traub and originally noted as new by him. The single specimen represents the southernmost record for the genus. Although *Baiomys musculus* is the type host, the true host may well be *Neotoma mexicana* whose range includes much of the state of Oaxaca, Mexico.

ACKNOWLEDGMENTS

The work reported here was supported by the Bureau of Vector Control, California State Health Department. Gratitude is due Dr. Deane P. Furman, Department of Entomology and Parasitology, University of California, Berkeley, under whose direction the work was completed, and to Mr. Frank M. Prince and Dr. Harold E. Stark for their helpful cooperation.

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The Adult Stages of *Ephemerella* (*Drunella*) *pelosa* Mayo

(Ephemeroptera : Ephemerellidae)

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A collection of mayflies on loan from the California Academy of Sciences included the previously undescribed adults of *Ephemerella pelosa* Mayo.

EPHEMERELLA PELOSA Mayo

Ephemerella pelosa Mayo 1951: 121; Allen and Edmunds 1956; 87; Day 1956: 98; Allen and Edmunds 1962: 164.

MALE IMAGO (in alcohol).—Length: body 9.0–10.0 mm; fore wing 10.5–11.5 mm. Head brown, black laterally; bases of ocelli black with a black line from median ocellus to ventral margin of head; upper portion of compound eyes orange, lower portion black. Pronotum light brown; mesonotum brown medially, light brown laterally; scutellum brown; pleura brown; pleural sutures white; thoracic sterna dark brown; sternal sutures purple; fore wing hyaline, stigmatic area opaque; primary longitudinal veins light brown, intercalary and cross veins pale; legs brown and yellow with black markings; forelegs brown; anterior surface of fore femora brown with black bands near apex and base (Fig. 2); fore tibiae dark brown; fore tarsi light brown; middle and hind legs yellowish brown; middle and hind femora yellowish brown with black bands near apex and base; middle and hind tibiae yellow with an apical black macula and suffused with black; tarsi yellow, suffused with black. Abdominal terga pale with purple markings (Fig. 4); abdominal sterna purple with pale lateral margins. Penes with a shallow emargination at apex, apices rounded, and each penis lobe with a ventral subapical protuberance (Fig. 3); subgenital plate between bases of forceps with a conical projection; terminal segment of genital forceps at least 2.5 times as long as broad. Caudal filaments brown.

FEMALE IMAGO (in alcohol).—Length: body 9.0–10.0 mm; fore wing 11.0–12.0 mm. General color paler than male. Head and thorax light brown. Abdominal

[1] The research upon which this report is based was supported by National Science Foundation Grant GB-2425.